Long-term Stability of Deep Subsurface Environments on Mars

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Evidence for hydrogen in the Martian subsurface from the neutron spectrometer aboard Mars Odyssey [*Boynton et al.*, 2002] suggests that water ice exists in the regolith over much of the surface. If this ice extends deep into the subsurface, a water/ice boundary will exist that, due to its depth, is unaffected by seasonal variations and largely immune to long-term changes in Mars' climate. Such an environment could act as an oasis for microorganisms that is buffered from the radical changes in climate, and may be presently inhabited. We present results from a latitude-dependent regolith diffusion model that computes the subsurface temperatures to depths of 3-6 km and tracks the location of such a water/ice boundary. Using results from a calculation of Mars' orbit over 1 billion years, we show this water/ice boundary is largely unaffected by changes in the orbital cycle, except during prolonged events of extreme obliquity. Once the subsurface temperatures are known, we can compute the diffusion of gases in the regolith, some of which may be of biogenic origin. Such a clement environment could support a complex ecosystem and this ecosystem could, in principle, generate a net amount of biologically produced methane. We use the model to compute molecular diffusion of methane in the regolith, and use recent observations of atmospheric methane abundance [*Formisano et al.*, 2004; *Krasnopolsky et al.*, 2004] to constrain potential ecosystem properties in the subsurface of Mars.

Boynton, W.V., W.C. Feldman, S.W. Squyres, T.H. Prettyman, J. Bruckner, L.G. Evans, R.C. Reedy, R. Starr, J.R. Arnold, D.M. Drake, P.A.J. Englert, A.E. Metzger, I. Mitrofanov, J.I. Trombka, C. d'Uston, H. Wanke, O. Gasnault, D.K. Hamara, D.M. Janes, R.L. Marcialis, S. Maurice, I. Mikheeva, G.J. Taylor, R. Tokar, and C. Shinohara, Distribution of Hydrogen in the Near Surface of Mars: Evidence for Subsurface Ice Deposits, *Science*, *297*, 81-85, 2002.

Formisano, V., S. Atreya, T. Encrenaz, N. Ignatiev, and M. Giuranna, Detection of Methane in the Atmosphere of Mars, *Science*, *306*, 1758-1761, 2004.

Krasnopolsky, V.A., J.P. Maillard, and T.C. Owen, Detection of methane in the martian atmosphere: evidence for life?, *Icarus*, *172*, 537-547, 2004.